(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 July 2003 (10.07.2003)

PCT

(10) International Publication Number
WO 03/056715 A1

(51) International Patent Classification[7]: H04B 3/54

(21) International Application Number: PCT/FI02/01000

(22) International Filing Date: 9 December 2002 (09.12.2002)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20012421 10 December 2001 (10.12.2001) FI

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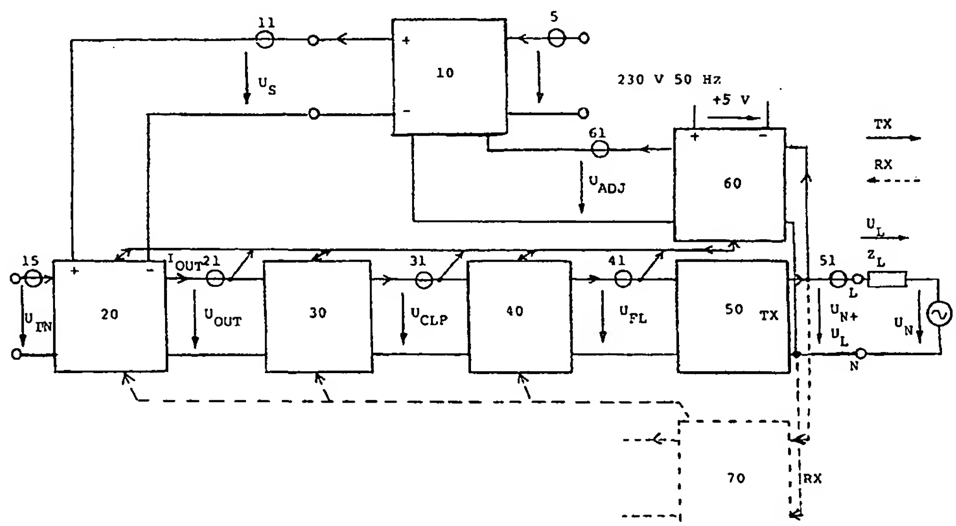
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CONTROLLING OF DATA TRANSMISSION VOLTAGE LEVEL BY CUTTING PRINCIPLE IN LOW VOLTAGE NET



(57) Abstract: Method to control the output signal of signal transmitter in a data system sending data in low voltage net in order to keep the utput signal voltage (U_L) constant, when output signal (U_L) is taken over coupling unit (50) to the network, whereby the data transmission includes a signal amplifier (20), a signal filter (40), a coupling unit (50) for signal coupling to the network and a source (10) of signal amplifier operating voltage (U_S). In connection with the signal amplifier (20) there is a signal clipper (30) or a function to clip output signal (U_{OUT}) of signal amplifier (20) and/or to clip or distort the input signal approaching signal amplifier (20) and clipping or distortion being directly or indirectly dependent on the output voltage (U_L) of the signal to be sent to the network or on the output current (I_{OUT}) from signal amplifier (20).

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Controlling of data transmission voltage level by cutting principle in low voltage net

The invention is suited for control of the voltage level of outgoing signals from transmitters in a data transmitting system sending data in low-voltage network. The aim is to keep the output signal as to its voltage level as constant as possible in the transmitter mains connection that is independent of net impedance, which impedance can sometimes be quite low and thus tending to attenuate the outgoing signal to a degree unfit for use with respect to reliable communication. Usually, by low-voltage a net of 230 V 50 Hz or some other low-voltage net is referred to.

In quite traditional systems the voltage amplitude of the outgoing signal drops strongly, when the impedance is attenuating. The maximum output level (EUROPE) can drop from 122 dBu V even to 16dBu V (1/6 voltage level) the net impedance then being 1 ohm. Mostly even this kind of systems can work reliably most of the time, but the fact that they are not always working correctly, make them, commercially thinking, unusable. Figure 1 shows a traditional solution.

In my opinion the most advanced modern techniques is in this respect represented by PCT application WO 01/15334 A1 (17.8.2000). In it the outgoing signal is kept almost constant in the transmitter mains connection by means of feedback coupling independent of net impedance and frequency. The method is based on the fact that the current feed capacity of the signal amplifier to a network of 230 V 50 Hz working as load is increased the more the lower the network impedance Z_L is. The above presented is a system , where in my opinion the signal (sinus shaped) is by no means cut from its peaks, but the signal amplifier pushes the more sinus shaped power to load Z_L the lower the Z_L is by each frequency. Thus outgoing signal U_L across Z_L remains almost constant. However, no curve $U_L= U_L (Z_L)$ is presented so there is no knowledge of the outgoing signal level, for instance by low Z_L values and also no knowledge of the quality of the invention.

The disadvantage of the feedback coupling system is, however, possible susceptibility against many kinds of disturbances appearing in the network if no interference suppression has been carried out most effectively. Also CE susceptibility tests the transmitters do not pass easily without good EMC characteristics. Effective suppression against interference increases the

manufacturing costs of transmitters a little. In this case situation is weakened because feedback signals U_M and 1_M x R_{CS} = U_{mess} are taken directly from points easily reached by disturbances from a network without suppression. If interference is carried out correctly and properly working, the method disclosed in the respective PCT publication is good.

The aim of this invention is to keep also output voltage U_L constant in net impedance $Z_{L,}$ with other words independent net impedance $Z_{L,}$ but in quite another way, that is by cutting the output voltage of the signal amplifier from its peak, or in another way by cutting or distorting when Z_L is high and output voltage U_L would without cutting tend to be too high. Alternatively cutting can be carried out by reducing the operating voltage of the signal amplifier so that cutting takes place already in the signal amplifier. After cutting the low pass filter and bandpass filter filter off harmonic waves generated on cutting under maximum level as required by standard. The method as per this invention is characterized in what is presented in the claims.

If the net impedance is low enough no signal cutting takes place but the maximum signal of signal amplifier is fed forward and further as such to the network. Thus an output voltage U_L, remaining constant, is achieved also with low net impedance values.

The input voltage U_{IN} of the signal amplifier is of constant amplitude as also the outlet voltage U_{OUT} of the signal amplifier (signal amplifier operating voltage U_S is constant, in other words ungovernable) . This holds true for the above presented text.

Described above is that cutting of outgoing signal can take place in signal amplifier or after it by cutting it from its peak. Another alternative is that the outgoing signal is cut in the signal amplifier or in subsequent blocks or in some other way. One possibility is 'zero point cutting', with other words the signal is cut from the centre so that positive and negative half periods can pass through as far their peaks are concerned, but from the root always a part of the half period is omitted. There are also other possible ways of cutting. If it is the question of a sinusoidal signal, the signal gets distorted on cutting and generated harmonic waves must be filtered off before getting fed into the network. Also such a method can be used that the input signal U_{IN} of signal amplifier is cut from line impedance Z_L directly or indirectly by a dependent way.

The control of output voltage U_L is in this invention always based on cutting the signal in one way or another . So it is not the question that the signal amplitude is controlled, while the signal is however retaining its original shape. It is quite another way of signal control (ALC and AGC), with other words automatic level control and automatic gain control.

ALC = Automatic Level Control

AGC = Automatic Level Control

In this invention keeping the level of outgoing signal U_L constant by the cutting principle takes place so that the transmitter sends a signal in principle at maximum level to the network, but he signal tending to grow by high Z_L values is restricted in early blocks by cutting or distorting.

The cutting system has no impact on power consumption, since power supply (U_S) must be dimensioned according to the situation of maximum load. Maximum power consumption appears when net impedance Z_L is at its lowest and just then the signal is not cut. By high Z_L the power consumption is small and the small increase of consumption due to cutting does not have any effect. Even in that respect an advantageous solution.

With respect to interference suppression the invention is advantageous, because usually there is no EMC susceptible feedback (especially when the cutting method is not used controlling the supply voltage source). On transmission disturbances across the network have no effect neither on transmitter operation in practise nor CE-susceptibility tests. Further, it is of great help that disturbances from the network are attenuated and meet at first the low-pass filter or band-pass filter and another interference suppression. As to its costs the cutting system is really profitable. As additional components for instance a capacitor C (e.g. 1 uF, ceramic or plastic capacitor) and two Zener diodes or, alternatively, a VDR resistor or another corresponding component. Generally, the cost price should be kept as low as possible in order to enable serial production and to be able to compete. The invention can be put into practice at low price and works also in bad interference conditions.

The cutting method according to the invention, as in the PCT-publication presented adjusting method of the outgoing signal level, is good enough for many applications in practise in the network as considered in relation to reliable data transmission.

In the following the invention is disclosed with reference to the enclosed table and drawing figures, where

Table 1 shows outgoing signal U_L as function of net impedance Z_L without signal cutting and with signal cutting.

Figure 1 shows a known traditional application.

Figure 2. shows the invention by means of a block diagram.

Figure 3 shows a practical application.

Figure 4. show the transmission level of a practical application in the network.

The dots of block diagram marked with small circles are numbered measuring points 5 ...61 In association with them an arrow is marked to illustrate voltage and or current symbol.

Block 10 is an adjustable voltage regulator, the out voltage U_S of which is adjustable in measuring point 61 by means of voltage U_{ADJ} available from control block 60.

The actual signal to be transmitted (e.g. under 90 kHz, 95-125 kHz, 125-140 kHz or 140-148,5 kHz) can be a sinusoidal or a square signal; input voltage U_{IN} in measuring point 15.

Block 20 is a signal amplifier where the above mentioned input signal is amplified and its great output signal U_{OUT} in measuring point 21 is fed into signal clipper 30. Signal U_{CLP} clipped in this way in measuring point 31 is fed further to the low-pass or band-pass filter 40, the output voltage of which U_{FL} is a very clean sinusoidal wave free of harmonic wave components. Signal U_{FL} in measuring point 41 is fed across coupling block 50 and through transmitter output connector (L – N) to the network, and to 'ride' onto the active net voltage U_N where it gets in U_L size across net impedance Z_L in measuring point 51 ($U_N + U_L$).

From block 50 output (measuring point 51) signal ($U_N + U_L$) is taken to feedback block 60, which gives directly a control voltage U_{ADJ} or another kind of variable proportional to signal U_L amplitude in measuring point 61 to control adjustable regulator 10, the direct voltage U_S given by it functions as operation voltage of signal amplifier 20. The greater the U_S the smaller the U_L tends to be and so in signal amplifier 20 the more the U_{OUT} gets clipped from its peak the smaller the U_S is. In this the U_{IN} is constant all the time as even the voltage amplification of signal amplifier 20. By so great net impedance values the output signal

amplitude U_L tending to grow is clipped almost to a constant value. By means of control voltage U_{ADJ} from feedback block 60 or another control variable can instead of adjustable regulator 10 block 20, 30 or 40 be controlled in order to clip or distort the signal.

If, on the other hand, the net impedance Z_L is very low, then also U_L is very low and U_S again at its maximum and there is no clipping in signal amplifier 20 and a maximum signal is achieved to the net impedance. Even by such low net impedances a signal as high as possible can be fed into the network. Block 60 can get into the U_L its proportional instead of measuring point 51(presented above) , for instance from measuring point 21, 31 or 41. Since adjustment of output signal U_L into a constant value in adjusting the U_S is not the most advantageous application, probably more advantageous methods presented in the following will used in signal clipping in order to keep output signal U_L constant.

Block 70 is a receiver and blocks 20 – 40 can also be controlled by direct voltage proportional to the transmission voltage receivable from receiver 70 or by some other control variable.

In the above description signal 30 clipper was not all in function. In the following block 60 is removed, while regulator 10 is continuously feeding constant maximum operating voltage U_{SMAX} as operating voltage of signal amplifier 20. The amplification of signal amplifier is constant, that is so high that output signal U_{OUT} hardly gets clipped at all or just a little from its peaks.

An alternative is to clip input signal U_{IN} the more the greater the Z_L and U_L are. However, if input signal U_{IN} is kept constant, clipping is carried out in signal clipper 30 in the cheapest way. It takes place so that there is a series resistance in the input connection of signal clipper 30 and after it a capacitor (if needed) followed by two zener diodes, transzorbs, a VDR resistor or some other similar clipping component.

If net impedance Z_L is very low, then the output current I_{OUT} of signal amplifier 20 is high. Thereby in serial resistance R of signal clipper 30 there is a great drop of voltage and, for instance, the zener diodes do not clip at all even a whole signal from its top, since the signal voltage across them is so low that the zener voltage is not exceeded. By high Z_L values the a the signal will be clipped strongly again. (Ref. Figure 3).

The signal can be clipped or distorted even in other ways and already in signal amplifier 20 and not until signal clipper 30. It can, for instance, take place as 'zero point clipping', whereby the peaks can pass without getting clipped but both signal half periods clipped from their root. It can be carried out by automatic adjustment of base emitter voltages U_{EB} of signal amplifier 20 power transistors in a way dependent on the U_L amplitude.

However, common to all adjustment ways is that adjustment takes place clipping the signal in one way or another and that the signals gets strongly distorted. The principle of distortion holds true if the signal amplifier 20 input signal U_{IN} and outgoing signal U_{OUT} are sinusoidal signals. If the signals are square signals, no distortion takes necessarily place even on clipping , since if a square wave is clipped from its peak, in the peak or in the centre, still the signal square shape remains square.

In the following an example is presented of a practical application with reference to figure 3 illustrating a practical application.

The operating voltage U_S of signal amplifier 20 is a regulated direct voltage, e.g + 15 V. Input signal U_{IN} (e.g. 95-125 kHz) can be a sinusoidal or a square wave 5 Vpp. The voltage gain of signal amplifier 20 is constant and of such kind that input signal U_{IN} does not get quite clipped or gets clipped slightly at signal amplifier output (U_{OUT} in measuring point 21). U_{OUT} is as to its amplitude about 15 Vpp either a sinusoidal or a square type signal. There is in signal clipper 30 a serial resistance R (many ohms), a serial capacitor (e.g. 1 uF) and two zener diodes Dl and D2, which do not at low net impedance X_L values clip signal U_{CLP} at all or only slightly but at net impedance Z_L high values (e.g. 50 ohm) they clip signal U_{CLP} from its peaks to a level determined by the zener diodes. Clipping is based on the fact that the drop of voltage I_{OUT} x R in resistor R is the lower the higher the net impedance Z_L.

Signal U_{CLP} the voltage level of which was made constant on clipping, is fed through low-pass or band-pass filter 40 and coupling block 50 to the network between phase and neutral. T_C is a coupling transformer an C_C a coupling capacitor.

Galvanic separation from the network takes place by means of net transformer T and the coupling transformer of signal T_C. (The coupling transformer could, of course, be even left

out and the signal coupled galvanically direct to the network through coupling capacitor C_C. However, for electrical safety galvanic separation is good).

Figure 4 shows the signal voltage U_L achievable by means of this practical application as function of network impedance Z_{LI}. U_{LI} is the output level according to the invention and the traditional and U_{L2} solution.

By means of operating voltage $U_S = + 15$ V as level U_L and as function of net impedance Z_L of signal amplifier 20, without signal clipping (zener diodes D_1 and D_2 excluded) and with signal clipping (zener diodes(D_1 and D_2 included) following values are measured:

U_L(Vpp)/Z_L (ohm)		U_L(Vpp)/Z_L (ohm)	
D_1 and D_2 are not	6,0/50	D_1 and D_2 is are	4,1/50
	4,8/5	Invention	3,5/5
	4,4/2		3,2/2
	3,1/1		2,7/1

Table 1. Output signal U_L as function of net impedance Z_L without and with signal clipping

If the operating voltage U_S is increased, then also by very low values (e.g. 1 ohm) of net impedance Z_L a higher output signal U_L than presented in table 1 and in figure 1 is achieved. In practice the significance of this is yet so small that it hardly pays to use an operating voltage higher than $U_S = + 15$ V.

Also using signal clipper components more effective and better than the zener diodes it is easier to keep the U_L constant.

CLAIMS

1. Method to control the output signal of signal transmitter in a data system sending data in low voltage net in order to keep the output signal voltage (U_L) constant, when output signal (U_L) is taken over coupling unit (50) to the network, whereby the data transmission includes:
- a signal amplifier (20)
- a signal filter (40)
- a coupling unit (50) for signal coupling to the network.
- a source (10) of signal amplifier operating voltage (U_S),
characterized in that in connection to the signal amplifier (20) there is a signal clipper (30) or a function to clip or to distort output signal (U_{OUT}) of signal amplifier (20) and/or to clip or distort the input signal approaching signal amplifier (20) and clipping or distortion being directly or indirectly dependent on the output voltage (U_L) of the signal to be sent to the network or on the output current (I_{OUT}) from signal amplifier (20).

2. Level control method according to claim 1 characterized in that the operating voltage (U_S) inversely proportional to output signal (U_L) of operating source (10) is delivered to signal amplifier (20).

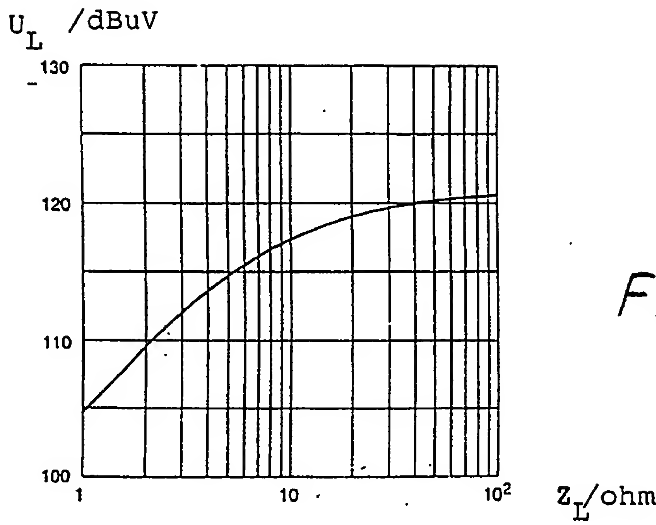
3. Level control method according to claim 1 or 2 characterized in that the inversely proportional output signal (U_S) is delivered under control by means of feedback coupling unit (60)

4. Level control method according to claim 1 characterized in that on transmission the signal to be sent is clipped or distorted by clipping input signal (U_{IN}) and/or output signal (U_{OUT}) in signal amplifier (20), signal (U_{OUT}) in signal clipper (30) and/or in other blocks directly or indirectly dependent on output signal voltage (U_L) or current (I_{OUT}) in order to keep output voltage (U_L) as independent as possible on net impedance (Z_L).

5. Level control method according to claim 1 characterized in that operating voltage (U_S) of signal amplifier (20) is adjusted by means of an adjustable regulator (10), the output voltage (U_S) of which is adjusted by means of feedback block (60) so that output voltage (U_{OUT}) of signal amplifier (20) also gets adjusted by means of said clipping making

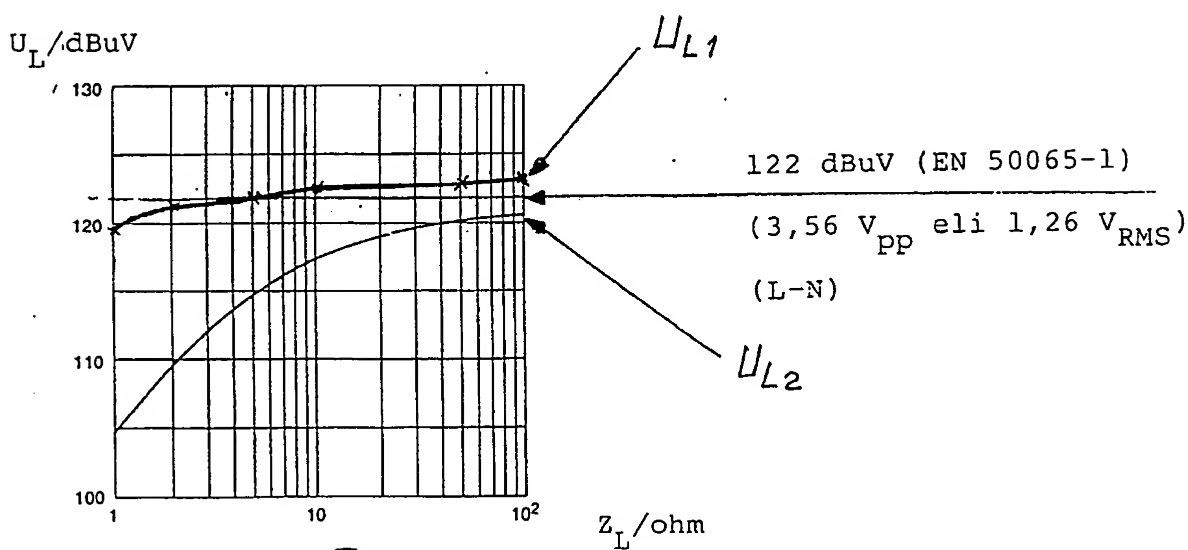
the output signal voltage (U_L) to remain as constant as possible and independent on net impedance (Z_L).

6. Level control method according to claim 1 characterized in that the signal voltage moving to blocks / through blocks 20-40 is adjusted by using direct voltage or some other adjusting variable proportional to output signal (U_L) achievable from receiver (70)



U_L /dBuV
130
120
110
100
1
10
10^2
Z_L/ohm

Fig. 1



U_L/dBuV
130
120
110
100
1
10
10^2
Z_L/ohm
U_{L1}
122 dBuV (EN 50065-1)
(3,56 V_{pp} eli 1,26 V_{RMS})
(L-N)
U_{L2}

Fig. 4

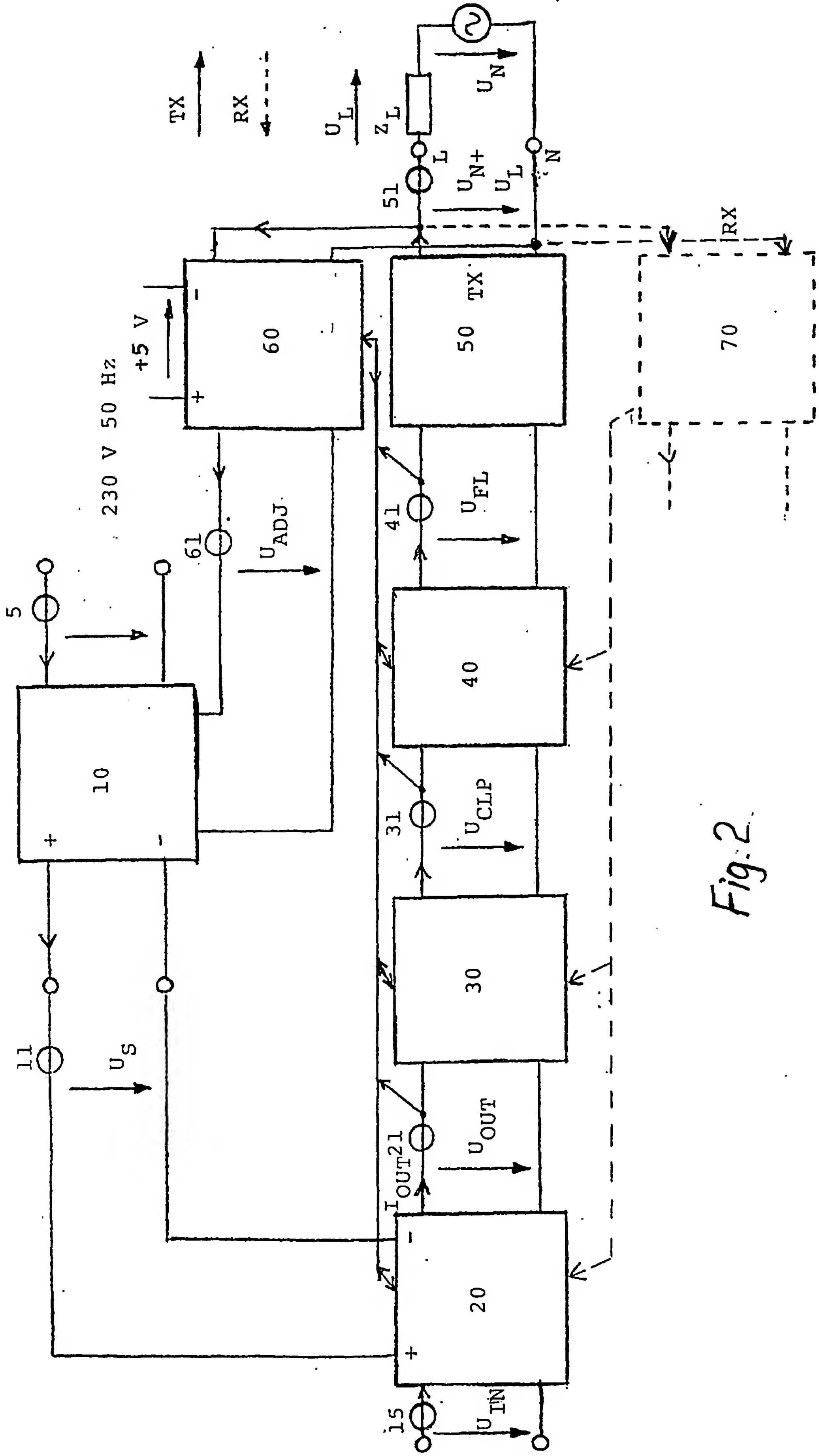

TX
RX
U_L
Z_L
U_N
L
N
51
U_N+ U_L
RX
60
50
TX
70
+5 V
230 V 50 Hz
61
U_ADJ
41
U_FL
5
40
10
31
U_CLP
30
11
U_S
I_OUT
21
U_OUT
20
15
U_IN

Fig. 2

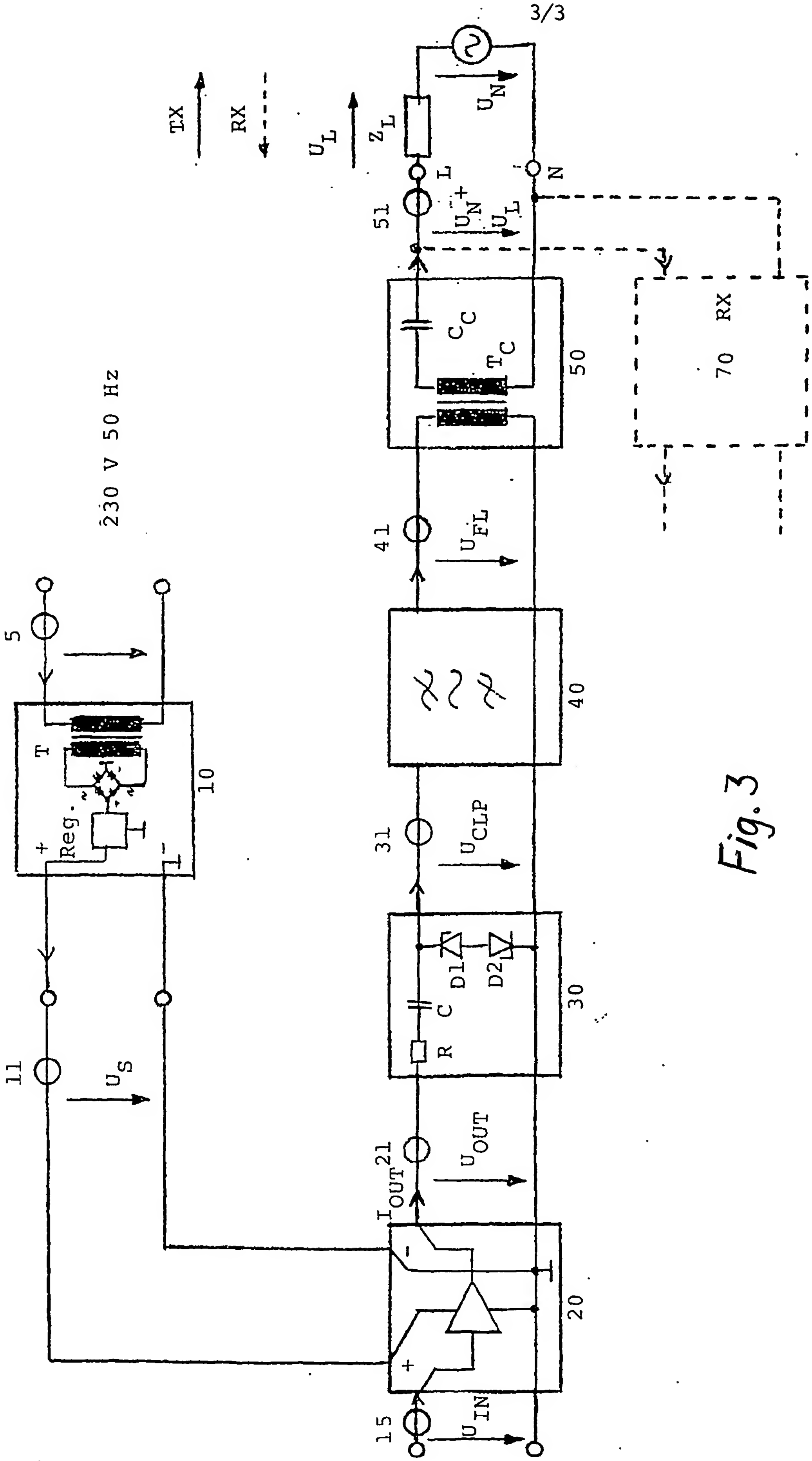

230 V 50 Hz
5
T
Reg.
10
11
U_S
TX
RX
U_L
Z_L
U_N
L
N
51
$U_N + U_L$
C_C
T_C
50
RX
70
41
U_{FL}
40
31
U_{CLP}
R
C
D1
D2
30
21
I_{OUT}
U_{OUT}
20
15
U_{IN}

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/01000

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 3/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H03G, H03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO INTERNAL, WPI DATA, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0267887 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 18 May 1988 (18.05.88), the whole document --	1-6
A	US 4451801 A (MONTICELLI, D.M.), 29 May 1984 (29.05.84), the whole document --	1-6
A	KHORRAMABADI, H. et al. "A highly-efficient CMOS line driver with 80 dB linearity for ISDN U-interface applications". In: 1992 IEEE INTERNATIONAL SOLID-STATE CIRCUITS CONFERENCE, 39TH ISSCC. DIGEST OF TECHNICAL PAPERS. San Francisco, CA, USA, 19 - 21 February 1992,pages 192 - 193, INSPEC AN: 4353058, see the whole document --	1-6

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search 17 March 2003	Date of mailing of the international search report 19 -03- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Markus Stålö /OGU Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1089453 A1 (STMICROELECTRONIC S.R.L.), 4 April 2001 (04.04.01), the whole document -- --------	1-6

INTERNATIONAL SEARCH REPORT
Information on patent family members

30/12/02

International application No.
PCT/FI 02/01000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0267887 A1	18/05/88	DE 3773124 A	24/10/91
		SE 455455 B,C	11/07/88
		SE 8604821 A	12/05/88
		US 4843345 A	27/06/89
US 4451801 A	29/05/84	DE 3230512 A	10/03/83
		FR 2511819 A,B	25/02/83
		JP 1907369 C	24/02/95
		JP 6018330 B	09/03/94
		JP 58066432 A	20/04/83
EP 1089453 A1	04/04/01	NONE	